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Description

The invention relates to a screw type vacuum pump comprising a pump casing having a suction inlet and a discharge outlet, a pair of rotors incorporated within that pump casing and rotatively carried at opposite ends thereof, said rotors meshing with each other to rotate in synchronized manner, working chamber means defined by said rotors and said pump casing, bearing means provided in said pump casing for carrying said rotors, and sealing means disposed in said pump casing associated with the respective bearing means.

Such a screw type vacuum pump as described in EP-A-0 166 851 is capable by itself of performing evacuation so as to achieve a low pressure of a level about 1,33 $\cdot$ 10^{-2} Pa. The pump is characterised in that working chambers thereof, which are defined by a male rotor, a female rotor and a casing, include two or three sealed sections between a suction port thereof and a discharge port thereof. The pump includes a working chamber for contributing a transfer stroke, which has been not needed by conventional compressors. As the rotors of the pump rotate, the working chambers thereof contribute to the strokes of suction, transfer, compression and discharge, respectively.

When used as a vacuum pump for general gases such as air or nitrogen gas, the above-described conventional pump has no problems. However, when used in a nitride film producing process in a low pressure chemical vapor deposition (CVD) device for manufacturing semiconductors, the rotors of such pump can become locked, which may incapacitate the pump. This is attributable to the great amount of reaction products present on a discharge side of the rotors, in particular on surfaces of tooth spaces contributing to the compression and the discharge strokes and on casing wall surfaces which correspond to the tooth space surfaces.

US-A-4 268 230 refers to a gas ballast device for an oil sealed mechanical rotary vane vacuum pump, which device is intended to prevent vapor condensation in the outlet port region of the low vacuum stage of the pump as a vane cyclically approaches the outlet port. To this end atmospheric air is introduced through the gas ballast device at the predetermined moment in the working cycle of the pump in order to prevent the vapor condensation. Thus, molecules of condensed vapor in the oil do not flow back to the low vacuum stage through an oil seal between the inlet port and the outlet port.

EP-A-0 156 096 A3 refers to a shaft seal for a gas pumping device comprising a mechanical seal and a labyrinth seal in form of a sliding bearing. A chamber between the mechanical seal and the sliding bearing is fed with lubricant for the bearing at a pressure being higher than the gas pressure on the other side of the mechanical seal so that there is no leakage of gas past the mechanical seal.

It is the object of the invention to improve the screw type vacuum pump of the generic kind such that a deposition of a process gas handled by the vacuum pump is prevented from accumulating on components of the vacuum pump.

This object is achieved with the screw type vacuum pump of the generic kind by means for introducing inert gas towards at least the sealing means associated with the bearing means adjacent said discharge outlet whereby a part of the inert gas flows into the discharge side sealing portion preventing lubricating oil from leaking from the associated bearing means to the working chamber means and whereby the rest of the inert gas flows towards the working chamber means lowering the partial pressure of process gas in the pump so that a side reaction product can hardly be disposited in the pump, and being adiabatically compressed to generate heat to heat the rotors and the pump casing preventing also accumulation of the side reaction product on the rotors and the pump casing.

Conveniently each of the rotors is provided with a plurality of helical lands and grooves, the working chamber means comprises a pair of working chambers defined by said rotors and said pump casing along the respective grooves of the rotors, one of said working chambers being for making a compression and a discharge function and the other working chamber being for making a suction and a transfer function, and said means for introducing inert gas introduce said inert gas into said discharging working chamber.

Preferably the means for introducing inert gas comprise at least one gear purge hole provided in the pump casing.

Advantageously the sealing means include in an axially fixed manner a seal ring, a spacer, a carbon ring, a screw seal, a seal retainer and a labyrinth, the screw seal being provided with a gas guide groove opposite to an opening of the gas purge hole.

In an advantageous embodiment of the invention flow control means are provided for exclusively allowing said inert gas passing into said working chamber means when a pumped process gas is sucked into said working chamber means.

Furtheron, a gear case, into which the part of the inert gas is passed that flows into the discharge side sealing portion, means for extracting said inert gas from said gear case and for separating oil from said inert gas, and passage lines may be provided for delivering said separated inert gas to the dis-

charge outlet.

Preferably a change valve means is provided for delivering said separated inert gas to said suction inlet during a predetermined period after operation of said pump and for delivering said separated inert gas to said discharge outlet after a lapse of said predetermined period.

With the screw type vacuum pump according to the invention a typical process for producing a silicon nitride film in a low pressure chemical vapor deposition device (CVD) can be carried out according to the following formula

$$3SiH_2Cl_2 + 10NH_3 \rightarrow SiN_4 + 6NH_4Cl + 6H_2$$

Ammonium chloride is generated as a side reaction product of this process. The higher the pressure becomes, the higher the depositability of ammonium chloride becomes due to the vapor pressure characteristics thereof. As a result, in a screw type vacuum pump, ammonium chloride accumulates on the surfaces of the rotor portions and the casing portions which cooperate with each other to define working chambers contributing to the compression and the discharge strokes, respectively. When an inert gas such as nitrogen gas is introduced into the working chambers, a partial pressure or a concentration of ammonium chloride in the mixture of such introduced inert gas and ammonium chloride is lowered, so that it becomes harder for the ammonium chloride to deposit.

Further, the inert gas in the working chambers is adiabatically compressed by pumping operation to heat the rotors and the casing wall. As a result, even though ammonium chloride is deposited as a side reaction product, it hardly adhere to or accumulate on the rotors and the casing wall.

In addition, the pump according to the present invention is provided with means for introducing an inert gas. The inert gas introducing means is provided in one of sealing portions for pump rotor shaft bearing portions, which is located in a discharge side of the pump. A part of inert gas introduced into the discharge side sealing portion flows into such discharge side sealing portion. The rest flows towards the working chambers to lower the density of the side reaction product. Further, the inert gas in the working chambers is adiabatically compressed to heat the rotors and the casing wall so as to prevent the side reaction product from accumulating on the rotors and the casing wall. The inert gas introduced into the discharge side sealing portion prevents lubricating oil from leaking from the bearing portion to the working chambers through the discharge side sealing portion.

Furtheron, embodiments of the invention are described including the accompanying drawings, in which

Fig. 1 is a longitudinal sectional view showing a screw type vacuum pump in accordance with one embodiment of the present invention;

Fig. 2 is a sectional view taken along the line II-II of Fig. 1;

Fig. 3 is a sectional view taken along the line III-III of Fig. 1;

Fig. 4 is a view showing an engagement between tooth spaces of the rotors in Fig. 1;

Fig. 5 is a p-v chart of the pump in Fig. 1;

Fig. 6 is a view showing an engagement between tooth spaces of the rotors in another embodiment;

Fig. 7 is a diagram showing a CVD device to which the vacuum pump according to the present invention is applied;

Fig. 8 is a fragmentary sectional view showing still another embodiment;

Fig. 9 is an enlarged fragmentary sectional view showing the sealing portion in Fig. 8; and

Fig. 10 is sectional view showing a further still another embodiment.

Referring to Figs. 1 to 3, a pump according to one embodiment of the present invention includes a casing 1, and a pair of rotors 4 and 5 accommodated within the casing 1. The casing 1 is constituted of a main casing portion 11, a discharge side casing portion 12 attached to one axial end of the main casing portion 11, and an end cover 13 attached to the other axial end of the main casing portion 11. The pair of rotors includes a male rotor 4 and a female rotor 5, each of which is provided with a plurality of spiral lands and a plurality of spiral grooves. The spiral lands of one of rotors mesh with the grooves of the other one. The rotors 4 and 5 cooperate with the main casing portion 11 and the discharge side casing portion 12 to define a working chamber means 6 therebetween. The main casing portion 11 is provided with a suction inlet 14 communicated to the working chamber means 6 and a gas purge hole 16 seving as an inert gas introducing means. The discharge side casing portion 12 is provided with a discharge outlet 15 communicated to the working chamber means 6. Further, the casing 1 is provided with a water jacket 2 through which water circulates to cool the rotors 4 and 5 and the casing 1.

The male rotor 4 is journaled at a suction side rotor shaft 4A and a discharge side rotor shaft 4B by bearings 7A and 7B, respectively. The female rotor 5 is journaled at a suction side rotor shaft 5A and a discharge side rotor shaft 5B by bearings 8A and 8B, respectively. These bearings 7A, 7B, 8A and 8B are, for example, rolling bearings.

The male rotor 4 and the female rotor 5 mesh with each other with a fine clearance therebetween

and they rotate in synchronized manner by means of timing gear means. The timing gear means include a male timing gear 9 mounted on the discharge side rotor shaft 4B, and a female timing gear 10 mounted on the discharge side rotor shaft 5B for meshing with the male timing gear 9. The bearings 7B and 8B and the timing gears 9 and 10 are lubricated by lubricating oil supplied by an oil pump (not shown) located outside of the vacuum pump. The male rotor 4 is sealed at the rotor shafts 4A and 4B by sealing means 17A and 17B, respectively. The female rotor 5 is also sealed at the rotor shafts 5A and 5B by sealing means 18A and 18B, respectively. The sealing means 17A, 17B, 18A and 18B serve to prevent lubricating oil from passing into the working chamber means 6 through the bearings 7A, 7B, 8A and 8B, and the timing gears 9 and 10.

In this embodiment, an oil scraping slinger 19 is provided at an end of the rotor shaft 5A of the rotor 5. On the rotation of the rotors 4 and 5, the slinger 19 splashes the bearings 7A and 8A with lubricating oil in an oil sump 20 defined by a part of the main casing 11 and a part of the end cover 13.

Fig. 4 shows a development of the rotor tooth spaces of the rotors 4 and 5 with centering an inter-sectional line a between a male bore and a female bore. The two-dot chain line, the dashed line and the broken line indicate positions corresponding to a suction port 24, a discharge port 25 and the gas purge hole 16, respectively.

The working chamber means 6 is divided into a suction working chamber 6a, a transfer working chamber 6b, a compression working chamber 6c and a discharge working chamber 6d, respectively with respect to a gas flow direction.

The vacuum pump explained above is connected at the suction side thereof to, for example, a vessel of a semiconductor manufacturing device, e.g. the low pressure CVD device so as to evacuate the vessel.

The operation of the above-mentioned screw type vacuum pump will be explained hereinunder with referring to Figs. 1, 2 and 4 when applied to the process of manufacturing silicon nitride film with using dichlorsilane (SiH_2Cl_2) and ammonia (NH_3) as process gas.

When an external drive mechanism (not shown) drives the pump, the male rotor 4 and the female rotor 5 rotate to introduce the process gas into the suction working chamber 6a from the suction inlet 14 through the suction port 24. The process gas is delivered through the transfer working chamber 6b and the compression working chamber 6c to the discharge working chamber 6d and then discharged therefrom to the discharge outlet 15 through the discharge port 25. Namely on the operation of the pump, the process gas flows from the suction inlet 14 to the discharge outlet 15 and during such operation the process gas is subjected to the suction stroke, the transfer stroke, the compression stroke and the discharge stroke in order.

Fig. 5 is a p-v diagram showing pressure levels of the process gas in the respective working chambers. In the diagram, sections e-f, f-g, g-h and h-i indicate the suction stroke, the transfer stroke, the compression stroke and the discharge stroke, respectively. In the semiconductor manufacturing process in which a vacuum pump capable of discharging gas at a level of rate of 1000 dm^3/min is required, dichlorsilane and ammonia are flown as process gas at levels of several tens of cc/min and several hundreds of cm^3/min, respectively. As apparent from the diagram, the pressure of the process gas is remarkably high in the compression and the discharge strokes. However, the partial pressures of dichlorsilane and ammonia can be lowered to the levels of 1/10 to 1/100 of that in a conventional pump by injecting inert gas such as nitrogen gas or argon gas at several dm^3/min to several tens dm^3/min into the working chambers of the pump through the gas purge hole 16.

In this embodiment, the partial pressure of the process gas is remarkably reduced thereby preventing ammonium chloride (NH_4Cl) from accumulating on the male and female rotors 4 and 5 and the inner wall of the casing 1.

Another embodiment will be explained hereinunder with referring to Fig. 6.

The positions of the gas purge holes 16 provided in the main casing portion 11 are indicated in a development of the rotor tooth spaces of Fig. 6. The gas purge holes 16 are opened along the tooth spaces of the rotors 4 and 5, so that the process gas are well mixed with the inert gas (nitrogen gas) to reduce the partial pressure of the process gas in the respective working chambers of the pump.

Next, the system of a low-pressure CVD device for manufacturing silicon nitride film will be explained hereinunder with referring to Fig. 7, to which the screw type vacuum pump according to still another embodiment is applied.

The screw type vacuum pump 36 is communicated with one end (discharge side end) of a reaction chamber 31 through a butterfly valve 35, an automatic pressure control valve means 34, and a main valve 32 and a slow discharge valve 33 disposed parallel to the main valve 32. Two gas passage lines 44 and 45 are communicated with the other end (suction side end) of the reaction chamber 31 through solenoid valves 41 and 42 and mass flow controllers 38 and 39, respectively. A nitrogen gas supply passage line 46 is communicated with the vacuum pump 36 through a solenoid valve 40 and a mass flow controller 37. Each

of mass flow controllers 37, 38 and 39 is a fine flow control means and can always control a flow rate of gas passing through a passage line to which it is mounted. The mass flow controller includes a flow rate sensor, a control valve and a control circuit therefor. The automatic pressure control valve means 34 serves to keep the pressure in the reaction chamber 31 at a predetermined level during reaction therein. The valve means 34 detects the pressure in the discharge side end of the reaction chamber 31 by a detecting means (not shown) and operates to keep such detected pressure in a predetermined level. In case that the pressure control in the reaction chamber 31 is effected by means of drive control of the vacuum pump 36, the valve means 34 is not necessary.

The butterfly valve 35 is normally in an open position. The valve 35 is closed, for example, to repair or maintain the vacuum pump 36. The solenoid valves 40, 41 and 42 are opened or closed in response to a command signal from through a control line 43.

Dichlorsilane (SiH_3Cl_2) flows in the gas passage line 45 into the reaction chamber 31 through the solenoid valve 42 and the mass flow controller 39. On the contrary, ammonia (NH_3) flows in the gas passage line 44 into the reaction chamber 31 through the solenoid valve 41 and the mass flow controller 38. Nitrogen gas (N_2) flows in the gas supply passage line 46 into the gas purge hole 16 of the pump 36 through the solenoid valve 40 and the mass flow controller 37. In this system, a common flow meter can be used instead of the mass flow controllers 37 and 39.

The main valve 32 has a discharge capacity larger than that of the slow discharge valve 33. Both valves 32 and 33 are always closed when the pump 36 is inoperated. The slow discharge valve 33 is changed to an open position on an initial operation stage of the pump 36 and discharge process gas from the reaction chamber 31 at a low flow rate. After a predetermined time elapses, the main valve 32 is also changed to an open position to cooperate with the slow discharge valve 33 to discharge process gas from the reaction chamber 31 at a mixmum flow rate.

When the valve open command signal is delivered through the control line 43 to the solenoid valves 41 and 42, they are opened to introduce dichlorsilane and ammonia into the reaction chamber 31. The valve open command signal is also delivered to the solenoid valve 40 to open it. Nitrogen gas is introduced into the working chamber means 6 of the pump 36 to reduce the partial pressure of the process gas (dichlorsilane gas and ammonia gas) in the pump 36. When the valve close command signal is delivered through the control line 43 to the solenoid valves 41 and 42, they are closed to block the flow of process gas into the reaction chamber 31. Simultaneously the solenoid valve 40 is also closed to block the flow of nitrogen gas into the pump 36, so that the base pressure in the reaction chamber 31 is kept in sufficiently low level.

According this, the partial pressure (density) of process gas in the pump 36 is reduced, so that the side reaction product can be hard to deposit in the pump 36. The inert gas is adiabatically compressed to generate heat to heat the rotors and the casing wall of the pump 36. This prevents the side reaction product from accumulating on the rotors and the casing wall of the pump 36, whereby improving the reliability of the pump 36.

With referring to Figs. 8 and 9 still another embodiment will be explained hereinunder.

In this embodiment, the gas purge hole 16 for introducing inert gas into the pump is so provided in the discharge side casing portion 12 that the introduced inert gas is directed towards the discharge side sealing means 18B. On operation of the screw type vacuum pump, the inert gas such as nitrogen gas or argon gas is introduced towards the sealing means 18B through the gas purge hole 16. The flow of the introduced inert gas is divided into two flows, one for the bearing 8B and the other for the working chamber means 6.

The other flow of the inert gas towards the working chamber means 6 is sucked thereinto by means of negative pressure generated in a space 50 defined by ends of the discharge side casing portion 12 and of the rotor 5. The inert gas sucked into the working chamber means 6 is adiabatically compressed therein to generate heat to heat the rotors 4 and 5 and the wall of the casing 1. According this, the side reaction product generated in semiconductor manufacturing process is fully discharged without accumulating on the rotors and the casing wall.

Further the inert gas is added to the process gas to reduce the partial pressure (density) thereof, so that the side reaction product is hard to deposit in the pump 36.

The one flow of the inert gas towards the bearing 8B prevents the lubricating oil from leaking from the bearing 8B to the working chamber means 6.

Hereinunder the discharge side sealing means 18B will be explained in detail with referring to Fig. 9.

The sealing means 18B includes a seal ring 51, a spacer 52, a carbon ring 53, a screw seal 54, a seal retainer 56 and a labyrinth 57 serving as a slinger. A ring 58 and a wave spring 59 are so disposed that these sealing members are clamped therebetween to fix the sealing means 18B in axial position. The screw seal 54 is provided with a gas

guide groove 54a opposite to an opening of the gas purge hole 16. According this, the introduced inert gas is smoothly delivered towards the sealing means 18B.

In this embodiment, in addition to these sealing members, a felt seal 50 is disposed adjacent the working chamber means 6 and is mounted in an annular groove formed in an inner wall of the discharge side casing portion 12 so as to contact with an outer periphery of the discharge side rotor shaft 5B. According this, the dust is prevented from flowing from the sealing means 18B to the bearing 8B, which dust is, for example, the deposited reaction product generated from gases between the working chamber means 6 and an outlet (not shown in Figs. 8 and 9) in the semiconductor manufacturing device. Further a gas tightness of the working chamber means 6 is improved, so that a higher negative pressure can be obtained.

A part of the inert gas introduced from the gas purge hole 16 is sucked into the working chamber means 6 and is adiabatically compressed therein to generate heat to heat the rotors and the casing wall. In general, a reaction product generated in a semiconductor manufacturing process remains in a gaseous form when heated, not deposit as solid substance. Therefore, the process gas can be discharged through the discharge outlet without clogging the pump.

Fig. 9 shows the structure of the discharge side sealing means 18B only. It should be noted that the suction side sealing means 18A has the same structure as the discharge side sealing means 18B except for the gas purge hole 16. However, it may be possible to introduce the inert gas from not only the discharge side sealing means 18B but also the suction side sealing means 18A by making the structure of the suction side sealing means 18A identical to that of the discharge side sealing means 18B.

Further it should be noted that the structure concerned in the male rotor 4, which has not been explained, has the same one of the female rotor 5 explained hereinabove.

In this embodiment, since the partial pressure (density) of the process gas in the pump is reduced, the deposition of side reaction product is inhibited. Further, by introducing the inert gas into the sealing means in an amount large enough to be adiabatically compressed to obtain heat by which the deposition of reaction product on the rotors 4 and 5 and the inner casing wall is inhibited, the pump may be used as a screw type dry vacuum pump for roughly discharge the reaction product from a line of a device, e.g. a semiconductor manufacturing device in which a great amount of reaction product is generated.

Further in case of a CVD device, it is a common practice to dilute the process gas discharged from the vacuum pump with duluter nitrogen gas and to discharge them to the scrubber in the safety point of view. In this embodiment, since nitrogen gas is delivered to the sealing means, such duluter nitrogen gas may be omitted. In addition, since the dilution is carried out within the vacuum pump, it can be possible to enhance the safety in operation of the vacuum pump.

It can be also possible to prevent lubricating oil from leaking from the bearings and the timing gears to the working chamber means through the sealing means.

The inert gas flowing towards the discharge side bearings urges lubricating oil to a gear case incorporating the timing gears. According this, lubricating oil is prevented from leaking into the working chamber means to obtain a clean vacuum.

On the other hand, since the inert gas accumulates within the gear case to increase the pressure therein, it becomes necessary to release the accumulated inert gas therefrom through vent means. However, since such inert gas contains the lubricating oil, it is preferable to separate lubricating oil from the inert gas and return it to an oil sump in the gear case.

The embodiment equipped with the vent means, in view of the above, will be explained hereinunder with referring to Fig. 10.

The gear case 60 attached to the casing 1 incorporate therein a pair of timing gears and an accelerating gear 62 fitted onto an output shaft of a motor 61 for meshing with one 9 of the timing gears. The gear case 60 accumulates a predetermined amount of lubricating oil which is supplied from an oil pump (not shown) through a supply nozzle (not shown) provided on the gear case 60.

First pressure balance line 63 extends from the gear case 60 to the discharge outlet 15. A first oil separator 64 and a second oil separator 65 are disposed in series in the first pressure balance line 63. Lubricating oil separated from the inert gas in the first oil separator 64 is returned to the oil sump in the gear case 60 through a return line 66.

Second pressure balance line 67 extends from a top of the end cover 13 to the suction inlet 14 so as to balance the pressures at the suction side oil sump 20 and the suction inlet 14. A fore-line trap 68 is disposed in the second pressure balance line 67. A change valve 69, e.g. a three way solenoid valve is disposed in the first pressure balance line 63 between the second oil separator 65 and the discharge outlet 15. The change valve 69 is changed over to communicate the gear case 60 to the oil sump 20 during a predetermined period after operation of the vacuum pump. Thereafter the change valve 69 is changed over to communicate

the gear case 60 to the discharge outlet 15 to balance the gear case 60 on the inert gas extraction.

The operation of the above explained vacuum pump will be described hereinunder.

The suction inlet 14 is connected to a vessel to be evacuated to introduce gas from the vessel as shown in an arrow into the working chamber means 6. The introduced gas is released from the discharge outlet 15 to the atmosphere through a discharge line and a silencer (both not shown).

Lubricating oil accumulated in a bottom of the gear case 60 is dispensed to portions to be lubricated respectively through an oil pump, an oil cooler and oil supply lines which are not shown.

On the operation of the vacuum pump, the inert gas containing lubricating oil passes through the first oil separator 64 in which a large part of lubricating oil is separated from the inert gas and is returned to the gear case 60 through the return line 66. The first oil separator 64 must cause little or negligible pressure loss. If the first oil separator 64 causes a large pressure loss, the pressure at an interior of the first oil separator 64 becomes lower than that at an inlet of the separator 64, which is identical with the pressure in the gear case 60. Consequently lubricating oil and inert gas flow back from the gear casing 60 (a lower pressure part) to an interior of the first oil separator 64 (a higher pressure part).

The remainder lubricating oil is separated from the inert gas in the fine oil separator 65 and the inert gas containing no lubricating oil is delivered to the discharge outlet 15. Fine lubricating oil passing through the second pressure balance line 67 is adsorbed by the fore-line trap 68.

According this, a complete dry screw type vacuum pump is presented.

As described above, in accordance with this embodiment, since lubricating oil contained in the inert gas to be supplied to the discharge side sealing means is removed from the inert gas, a complete dry screw type vacuum pump having improved seal performance is provided.

Claims

1. A screw type vacuum pump comprising
   - a pump casing (1) having a suction inlet (14) and a discharge outlet (15),
   - a pair of rotors (4, 5) incorporated within said pump casing (1) and rotatively carried at opposite ends thereof, said rotors (4, 5) meshing with each other to rotate in synchronized manner
   - working chamber means (6) defined by said rotors (4, 5) and said pump casing (1),
   - bearing means (7A, 8A; 7B, 8B) provided in said pump casing (1) for carrying said rotors (4, 5) and
   - sealing means (17A, 18A; 17B, 18B) disposed in said pump casing associated with the respective bearing means (7A, 8A; 7B, 8B),

   characterized by
   - means (16) for introducing an inert gas towards at least the sealing means (17B, 18B) associated with the bearing means (7B, 8B) adjacent said discharge outlet (15),
   - whereby a part of said inert gas flows into the discharge side sealing portion preventing lubricating oil from leaking from the associated bearing (7B, 8B) to the working chamber means (6) and
   - whereby the rest of the inert gas flows towards the working chamber means (6) lowering the partial pressure of process gas in the pump so that a side reaction product can hardly be deposited in the pump, and being adiabatically compressed to generate heat to heat the rotors (4, 5) and the pump casing (1) preventing also accumulation of the side reaction product on the rotors (4, 5) and the pump casing (1).

2. A screw type vacuum pump according to claim 1,
   - wherein each of the rotors (4, 5) is provided with a plurality of helical lands and grooves,
   - the working chamber means (6) comprise a pair of working chambers defined by said rotors (4, 5) and said pump casing (1) along the respective grooves of the rotors (4, 5), one of said working chambers being for making a compression (6c) and a discharge (6d) function and the other working chamber being for making a suction (6a) and a transfer (6b) function and
   - wherein said means (16) for introducing inert gas introduce said inert gas into said discharging working chamber (6d).

3. A screw type vacuum pump according to claim 1 or 2, wherein means (16) for introducing inert gas comprise at least one gas purge hole (16) provided in the pump casing (1).

4. A screw type vacuum pump according to one of the claims 1 to 3, wherein the sealing means (18B) include in an axially fixed manner a seal ring (51), a spacer (52), a carbon ring

(53), a screw seal (54), a seal retainer (56), and a labyrinth (57), the screw seal (54) being provided with a gas guide groove (54a) opposite to an opening of the gas purge hole (16).

5. A screw type vacuum pump according to one of the claims 1 to 4, wherein flow control means (37, 40) are provided for exclusively allowing said inert gas passing into said working chamber means (6) when a pumped process gas is sucked into said working chamber means (6).

6. A screw type vacuum pump according to one of the claims 1 to 5,
   - wherein a gear case (60) is provided into which the part of the inert gas is passed, that flows into the discharge side sealing portion,
   - wherein means (63, 64, 65) are provided for extracting said inert gas from said gear case (60) and for separating oil from said inert gas, and
   - wherein passage lines are provided for delivering said separated inert gas to the discharge outlet (15).

7. A screw type vacuum pump according to claim 6, wherein a change valve means (69) is provided for delivering said separated inert gas to said suction inlet (14) during a predetermined period after operation of said pump and for delivering said separated inert gas to said discharge outlet (15) after a lapse of said predetermined period.

Patentansprüche

1. Schraubenvakuumpumpe mit
   - einem einen Ansaugeinlaß (14) und einen Abführauslaß (15) aufweisenden Pumpengehäuse (1),
   - einem Paar von in das Pumpengehäuse (1) eingebauten Rotoren (4, 5), die drehbar an dessen gegenüberliegenden Enden gelagert sind, wobei die Rotoren (4, 5) so miteinander kämmen, daß sie synchron drehen,
   - einer Arbeitskammereinrichtung (6), die von den Rotoren (4, 5) und dem Pumpengehäuse (1) gebildet wird,
   - Lagereinrichtungen (7A, 8A; 7B, 8B), die in dem Pumpengehäuse (1) zur Lagerung der Rotoren (4, 5) vorgesehen sind, und
   - Dichtungseinrichtungen (17A, 18A; 17B, 18B), die in dem Pumpengehäuse angeordnet und den jeweiligen Lagereinrichtungen (7A, 8A; 7B, 8B) zugeordnet sind,

   gekennzeichnet durch
   - Einrichtungen (16) für eine Einführung eines Inertgases in Richtung wenigstens der Dichtungseinrichtungen (17B, 18B), die den an den Förderauslaß (15) angrenzenden Lagereinrichtungen (7B, 8B) zugeordnet sind,
   - wobei ein Teil des Inertgases in den förderseitigen Dichtungsabschnitt strömt, der einen Leckstrom von Schmieröl aus dem zugeordneten Lager (7B, 8B) zu der Arbeitskammereinrichtung (6) verhindert und
   - wobei der Rest des Inertgases in Richtung der Arbeitskammereinrichtung (6) strömt und dabei den Partialdruck des Prozeßgases in der Pumpe so verringert, daß sich ein Nebenreaktionsprodukt kaum in der Pumpe ablagern kann, und adiabat komprimiert wird, um Wärme zur Erwärmung der Rotoren (4, 5) und des Pumpengehäuses (1) zu erzeugen, wodurch außerdem eine Anhäufung des Nebenreaktionsprodukts an den Rotoren (4, 5) und an dem Pumpengehäuse (1) verhindert wird.

2. Schraubenvakuumpumpe nach Anspruch 1,
   - bei der jeder der Rotoren (4, 5) mit einer Vielzahl von schraubenförmigen Vorsprüngen und Nuten versehen ist,
   - die Arbeitskammereinrichtung (6) ein Paar von Arbeitskammern aufweist, die von den Rotoren (4, 5) und dem Pumpengehäuse (1) entlang der jeweiligen Nuten der Rotoren (4, 5) gebildet werden, wobei eine der Arbeitskammern zur Durchführung einer Kompression (6c) und einer Förderfunktion (6d) und die andere Arbeitskammer zur Durchführung eines Ansaugvorgangs (6a) und einer Überführfunktion (6b) vorgesehen ist und
   - bei der die Einrichtungen (16) zur Einführung des Inertgases das Inertgas in die fördernde Arbeitskammer (6d) einführen.

3. Schraubenvakuumpumpe nach Anspruch 1 oder 2, bei der die Einrichtungen 16 zur Einführung des Inertgases wenigstens eine in dem Pumpengehäuse (1) vorgesehene Gasspülöffnung (16) aufweist.

4. Schraubenvakuumpumpe nach einem der Ansprüche 1 bis 3, bei der die Dichtungseinrichtungen (18B) in axial befestigter Weise einen Dichtungsring (51), ein Distanzstück (52), einen

Kohlenstoffring (53), eine Schraubendichtung (54), einen Dichtungshalter (56) und ein Labyrinth (57) enthalten, wobei die Schraubendichtung (54) mit einer Gasführungsnut (54a) gegenüber einer Öffnung der Gasspülöffnung (16) versehen ist.

5. Schraubenvakuumpumpe nach einem der Ansprüche 1 bis 4, bei der Strömungssteuereinrichtungen (37, 40) vorgesehen sind, damit nur das Inertgas in die Arbeitskammereinrichtung (6) eintreten kann, wenn ein gepumptes Prozeßgas in die Arbeitskammereinrichtung (6) gesaugt wird.

6. Schraubenvakuumpumpe nach einem der Ansprüche 1 bis 5,
   - bei der ein Getriebegehäuse (60) vorgesehen ist, in das der Teil des Inertgases geführt wird, der in den förderseitigen Dichtungsabschnitt strömt,
   - bei der Einrichtungen (63, 64, 65) für ein Abführen des Inertgases aus dem Getriebegehäuse (60) und zur Abtrennung von Öl aus dem Inertgas vorgesehen sind, und
   - bei der Leitungen vorgesehen sind, um das abgetrennte Inertgas zum Abführauslaß (15) zu liefern.

7. Schraubenvakuumpumpe nach Anspruch 6, bei der eine Umschaltventileinrichtung (69) zur Lieferung des abgetrennten Inertgases zum Ansaugeinlaß (14) während eines vorherbestimmten Zeitabschnitts nach dem Betrieb der Pumpe und zur Lieferung des getrennten Inertgases zum Abführauslaß (15) vorgesehen ist, nachdem der vorherbestimmte Abschnitt verstrichen ist.

Revendications

1. Pompe à vide du type à vis comprenant
   - un carter de pompe (1) possédant une entrée d'aspiration (14) et une sortie de refoulement (15),
   - un couple de rotors (4,5) incorporés dans ledit carter de pompe (1) et supportés à leurs extrémités opposées, de manière à pouvoir tourner, lesdits rotors (4,5) engrenant réciproquement pour tourner d'une manière synchrone,
   - des moyens (6) formant chambres de travail, définis par lesdits rotors (4,5) et ledit carter de pompe (1),
   - des moyens formant paliers (7A,8A; 7B,8B) prévus dans ledit carter de pompe (1) pour supporter lesdits rotors (4,5),

   et
   - des moyens d'étanchéité (17A,18A; 17B,18B) disposés dans ledit carter de pompe en étant associés aux moyens respectifs formant paliers (7A,8A; 7B,8B),

   caractérisée par
   - des moyens (16) pour introduire un gaz inerte en direction d'au moins les moyens d'étanchéité (17B,18B) associés aux moyens formant paliers (7B,8B) au voisinage de ladite ouverture de refoulement (15),
   - une partie dudit gaz inerte pénétrant dans la partie d'étanchéité située sur le côté refoulement en empêchant l'huile de lubrification de fuir depuis le palier associé (7B,8B) en direction des moyens formant chambres de travail (6), et
   - le reste du gaz inerte circule en direction des moyens formant chambres de travail (6) en réduisant la pression partielle du gaz de traitement dans la pompe de sorte qu'un produit secondaire de réaction peut difficilement se déposer dans la pompe, et en étant comprimé de façon adiabatique pour produire une chaleur de manière à chauffer les rotors (4,5) et le carter de pompe (1), ce qui empêche également une accumulation du produit secondaire de réaction sur les rotors (4,5) et dans le carter de pompe (1).

2. Pompe à vide du type à vis selon la revendication 1,
   - dans laquelle chacun des rotors (4,5) est équipé d'une pluralité de portées et de gorges hélicoïdales,
   - les moyens formant chambres de travail (6) comprennent un couple de chambres de travail définies par lesdits rotors (4,5) et ledit carter de pompe (1) le long des gorges respectives des rotors (4,5), l'une desdites chambres de travail assumant une fonction de compression (6c) et une fonction de refoulement (6d) et l'autre chambre de travail servant à assumer une fonction d'aspiration (6a) et une fonction de transfert (6b), et
   - dans lequel lesdits moyens (16) d'introduction du gaz inerte introduisent ledit gaz inerte dans ladite chambre de travail de refoulement (6a).

3. Pompe à vide du type à vis selon la revendication 1 ou 2, dans laquelle des moyens (16) pour introduire un gaz inerte comprennent au moins un trou (16) de purge du gaz, prévu dans le carter de pompe (1).

4. Pompe à vide du type à vis selon l'une des revendications 1 à 3, dans laquelle les moyens d'étanchéité (18B) comprennent, d'une manière fixée axialement, une bague d'étanchéité (51), une entretoise (52), une bague en carbone (53), un joint de vis (54), un dispositif (56) de retenue de joint d'étanchéité, et un labyrinthe (57), le joint de vis (54) étant pourvu d'une rainure (54a) de guidage du gaz à l'opposé d'une ouverture du trou (16) de purge du gaz.

5. Pompe à vide du type à vis selon l'une quelconque des revendications 1 à 4, dans laquelle des moyens de commande d'écoulement (37,40) sont prévus de manière à permettre exclusivement audit gaz inerte de pénétrer dans lesdits moyens formant chambres de travail (6) lorsqu'un gaz de traitement pompé est introduit par aspiration dans lesdits moyens formant chambres de travail (6).

6. Pompe à vide du type à vis selon l'une des revendications 1 à 5,
   - dans laquelle il est prévu un carter d'engrenages (60), dans lequel pénètre la partie du gaz inerte qui pénètre dans la partie d'étanchéité située côté refoulement,
   - dans laquelle il est prévu des moyens (63,64,65) pour extraire ledit gaz inerte dudit carter d'engrenages (60) et séparer l'huile dudit gaz inerte,
   - dans laquelle des conduits de passage sont prévus pour délivrer ledit gaz inerte séparé à la sortie de refoulement (15).

7. Pompe à vide du type à vis selon la revendication 6, dans laquelle des moyens formant vanne de commutation (69) sont prévus pour l'envoi dudit gaz inerte séparé à ladite entrée d'aspiration (14) pendant une période prédéterminée après le fonctionnement de ladite pompe et pour la délivrance dudit gaz inerte séparé à ladite sortie de refoulement (15) au bout de l'écoulement de ladite période prédéterminée.

FIG. 1

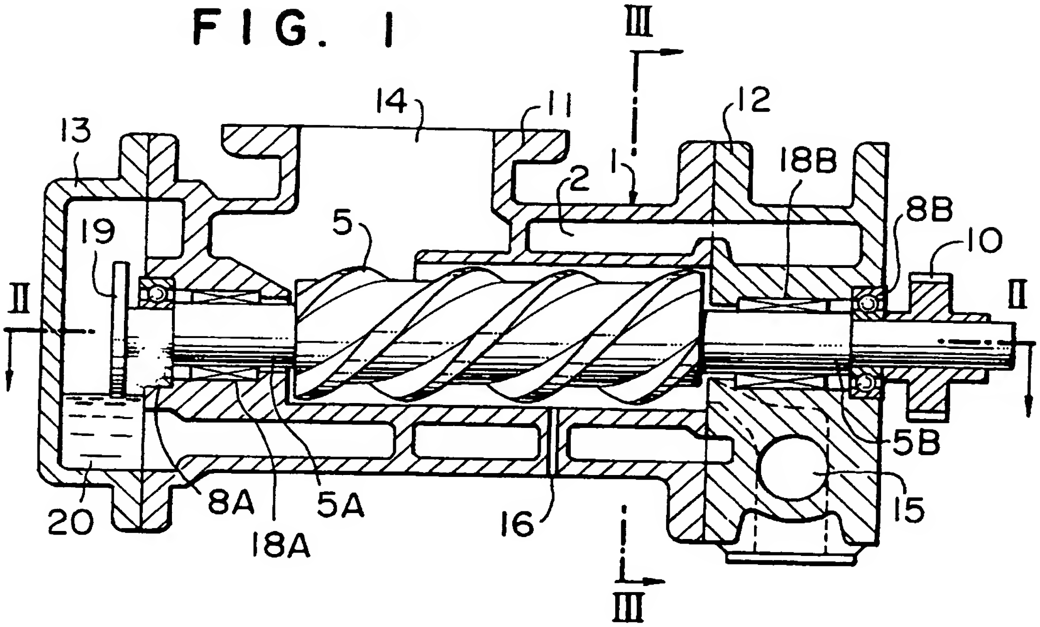

III
14
11
12
13
1
18B
2
8B
19
5
10
II
II
8A
5A
5B
20
16
15
18A
III

FIG. 2

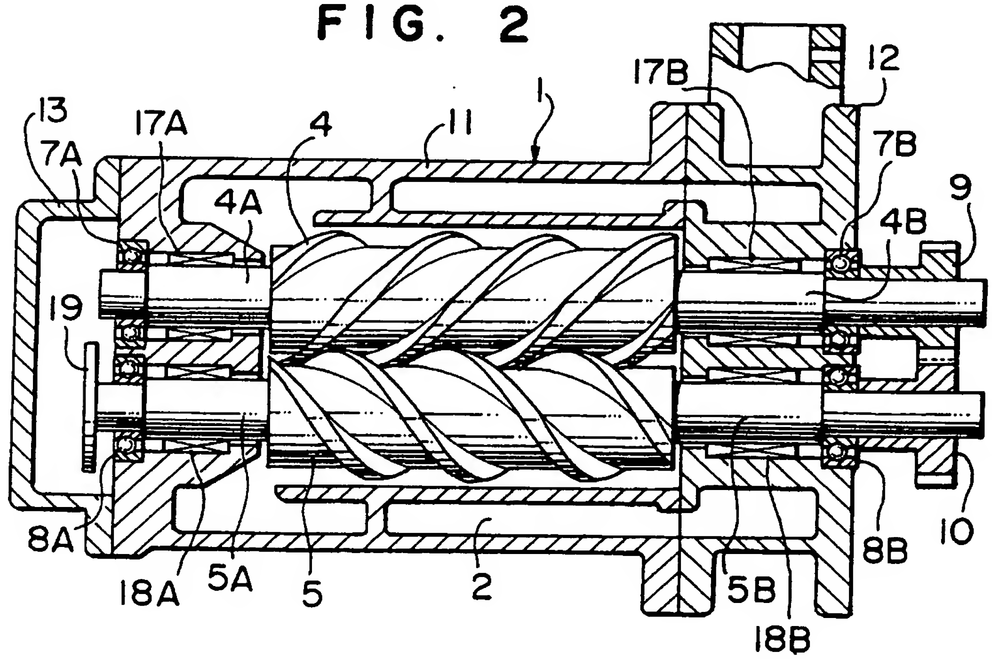

17B
12
13
1
7A
17A
4
11
7B
4A
9
4B
19
8A
18A
5A
5
2
5B
8B
10
18B

FIG. 3

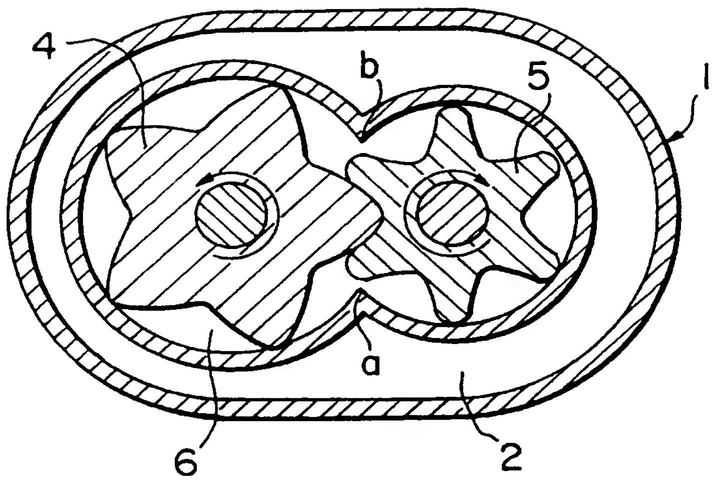


FIG. 4

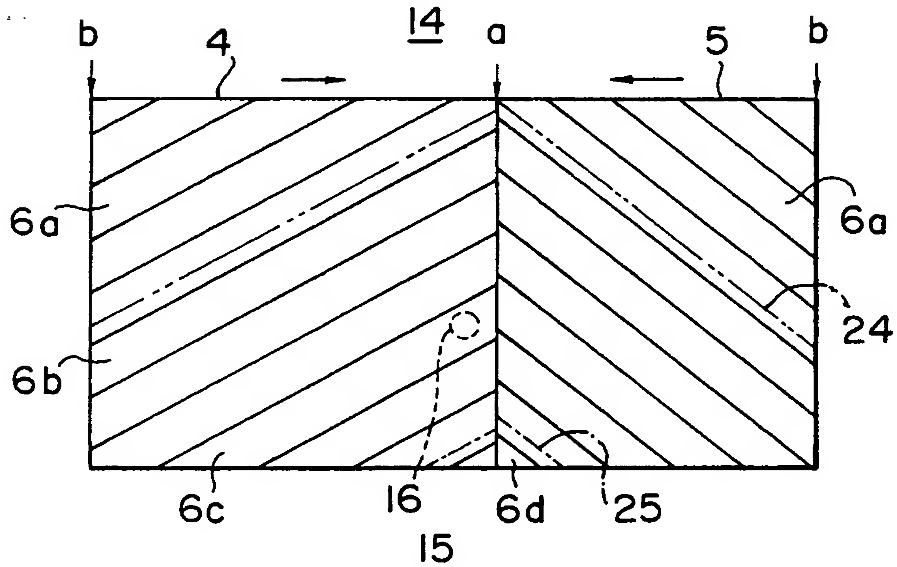


FIG. 5

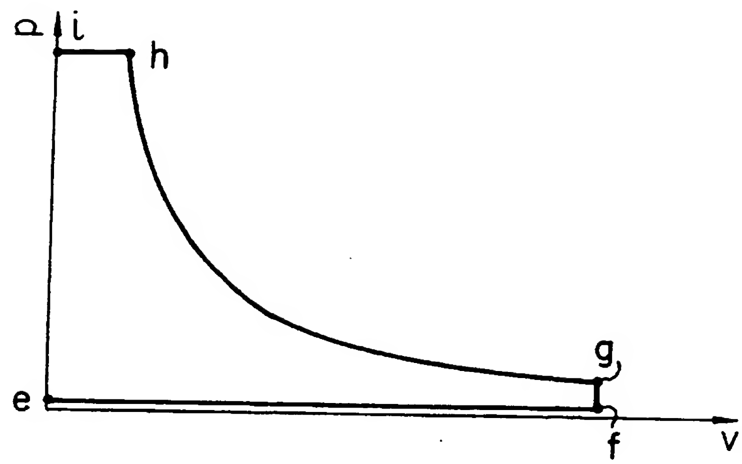


FIG. 6

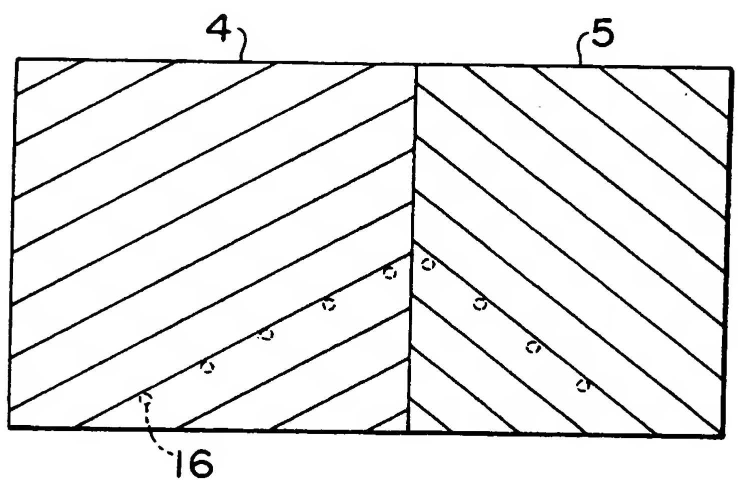


FIG. 7

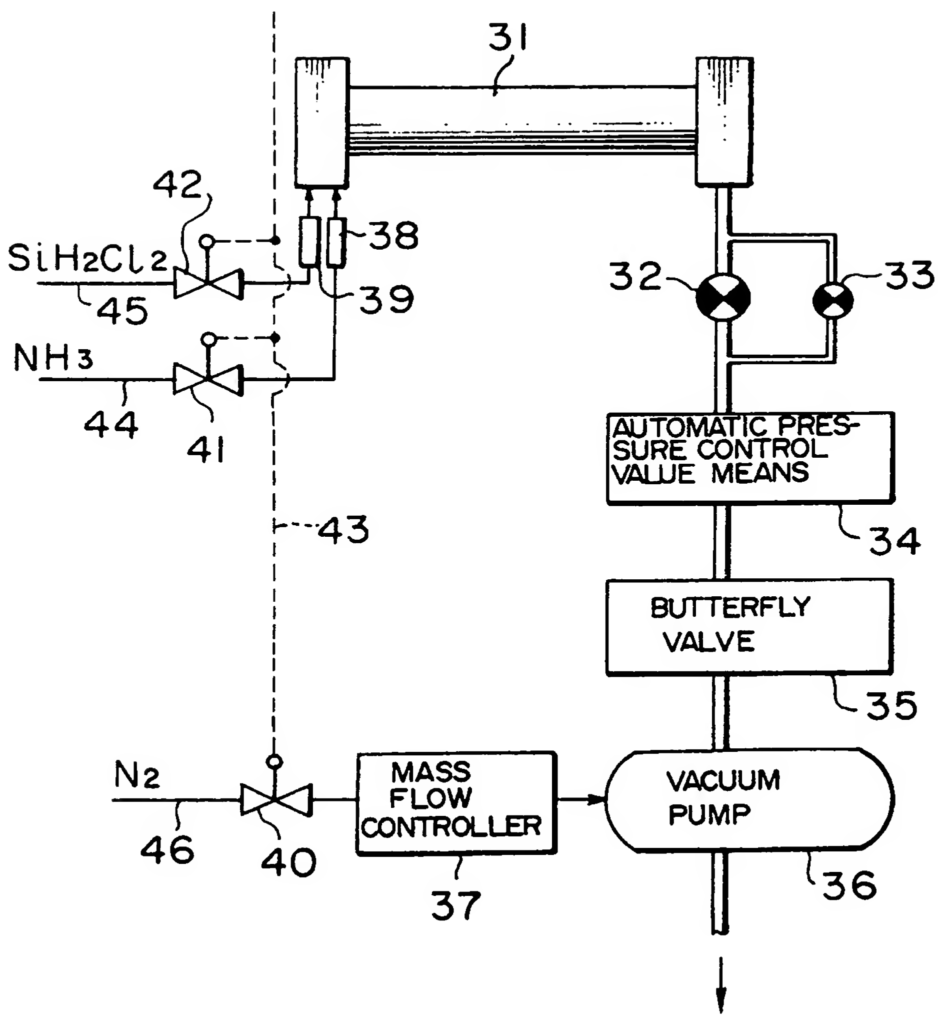

31
42
SiH2Cl2
45
38
39
NH3
44
41
43
32
33
AUTOMATIC PRESSURE CONTROL VALUE MEANS
34
BUTTERFLY VALVE
35
N2
46
40
MASS FLOW CONTROLLER
37
VACUUM PUMP
36

FIG. 8

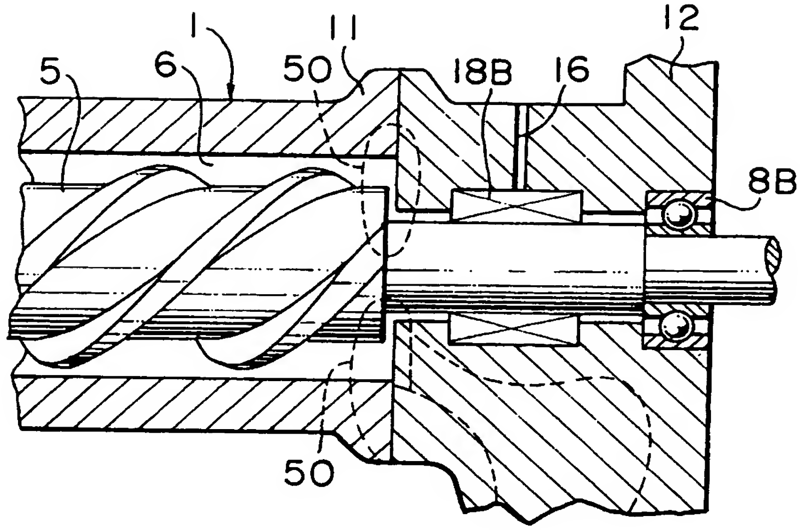

1
5
6
50
11
18B
16
12
8B
50

FIG. 9

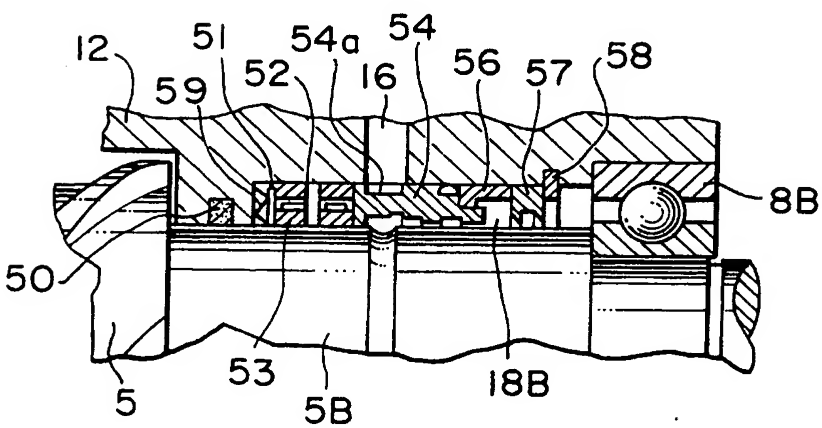
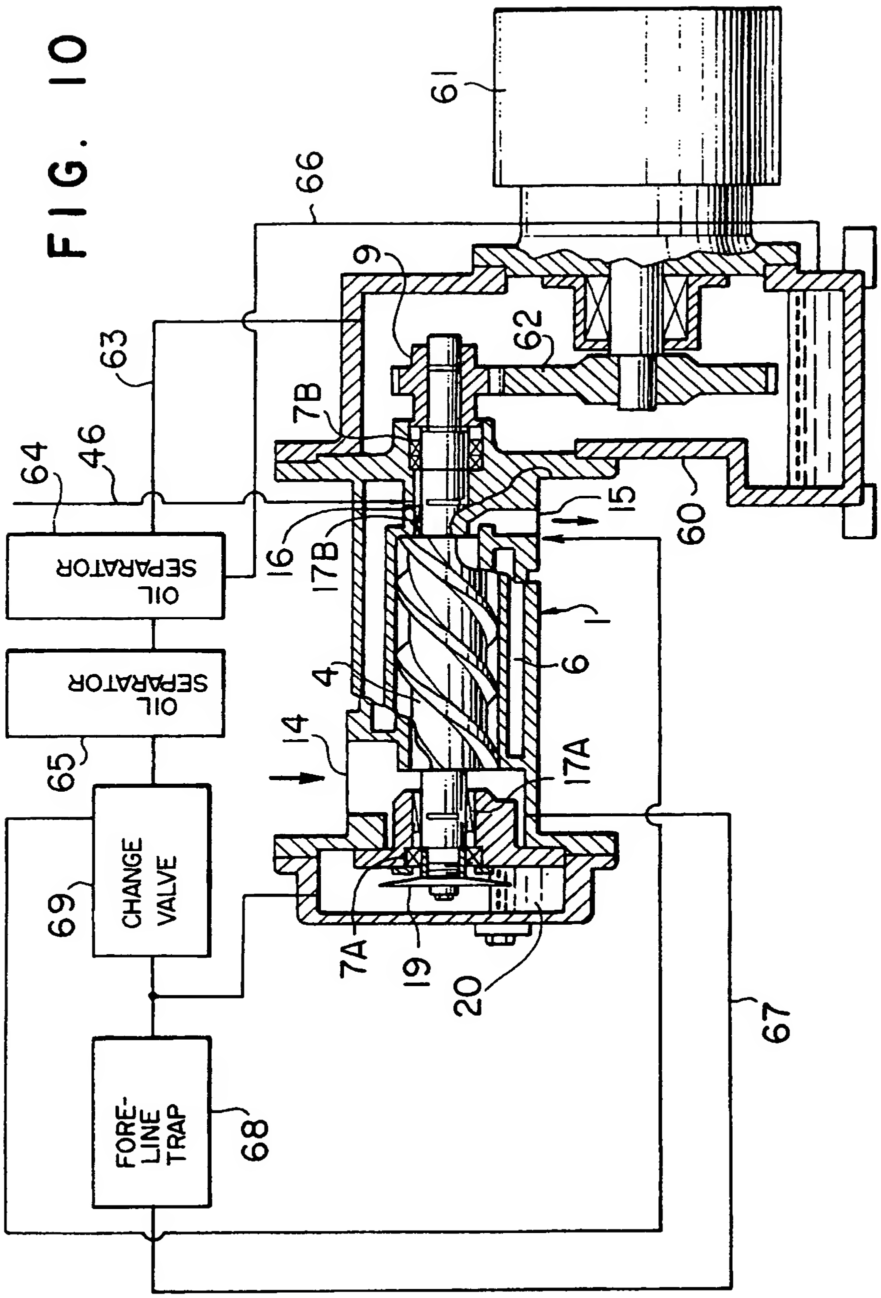

12
59
51
52
54a
54
16
56
57
58
8B
50
5
53
5B
18B

FIG. 10


OIL SEPARATOR
OIL SEPARATOR
CHANGE VALVE
FORE-LINE TRAP
61
66
63
64
46
9
62
7B
15
60
16
17B
1
6
4
14
17A
7A
19
20
65
69
68
67